Commentary

COMPLEXITY AND THE FUTURE
(Co-evolutionary Complexity and Mastering of Time)

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1. FROM LINEAR TO NONLINEAR THINKING

In order to understand the modern complex and changeable world, which is full of instabilities and crises, we have to master a complex nonlinear thinking. The basis for such thinking is the modern theory of complexity, which is under development under a number of different names, viz. nonlinear dynamics, the theory of selforganization, the theory of dissipative structures, fractal geometry, studies in deterministic chaos, the theory of autopoiesis, etc. Following Hermann Haken, the Russian scientific community calls this field of scientific research 'synergetics' (Haken 1977). Klaus Mainzer is absolutely right when he states in his fundamental book, which will soon appear in Russian:
"Linear thinking may be dangerous in a nonlinear complex reality … Our physicians and psychologists must learn to consider humans as complex nonlinear entities of mind and body. Linear thinking may fail to yield a successful diagnosis. Local, isolated, and 'linear' therapies of medical treatment may cause negative synergetic effects. In politics and history, we must remember that mono-causality may lead to dogmatism, intolerance, and fanaticism… We need new models of collective behavior depending on the different degrees of our individual faculties and insights. In short: The complex system approach demands new consequences in *epistemology and ethics" (Mainzer 2004, 15).*
The very essence of the modern research in nonlinear dynamics of complex systems is connected with the ability to transfer the models of complex behavior from one disciplinary field of knowledge to another, i.e., to do a special research when having a general and profound understanding of common patterns of complex behavior in nature and society. When trying to develop the complex nonlinear thinking and its epistemological and ethical consequences, it rests upon unique and little known (for the Western scientific community) results of computational experiments and mathematical modeling of course of processes in complex dissipative systems, of situations of instability and of scenarios of passing through a crisis, which have been obtained during the last decades by the Moscow scientific school of synergetics with its center at the Keldysh Institute of Applied Mathematics of the Russian Academy of Sciences (RAS) and at the Institute of Philosophy of the RAS. Besides, teaching in the capacity of Professor of the Russian Academy of Public Service by the President of the Russian Federation, I try to 256 Helena Knyazeva combine theory and practice, namely the theory of social self-organization and the practice of the Russian reform of governance, which is carried out through the preparation and the raising of the level of skill of personnel of public service in Russia, and through the elaboration of new educational courses and programs on 'social innovations', 'anti-crisis management of innovation processes', 'risk management', 'creative management', and 'innovation self-management'.

2. TO THINK NONLINEARLY MEANS TO CONSIDER ALTERNATIVES OF DEVELOPMENT

'Nonlinearity' is a fundamental conceptual knot of the new post-nonclassical scientific paradigm. The paradigm may be probably called the paradigm of nonlinearity. The complex thinking is, first of all, a nonlinear thinking. Therefore, it is important to understand various implications of the notion of nonlinearity, including its most general, philosophical sense. Considered from the mathematical point of view, nonlinearity signifies a certain type of mathematical equations which contain unknown quantities in powers more than 1 or coefficients depending on properties of a medium (system). Nonlinear equations can have several, more than one, qualitatively different solutions. Hence follows the physical sense of nonlinearity. A certain set of solutions of a nonlinear equation corresponds to a

multitude of evolutionary paths of system which is described by the equation (a nonlinear system). The *idea of nonlinearity* has a profound philosophical sense. It can be developed by a few more intelligible ideas, namely: the *idea of multiplicity of evolutionary paths*, the availability of alternative paths of evolution (it is well worth to underline here the fact that a large number of evolutionary paths is characteristic even for one and the same, invariable, open and nonlinear medium, or system); the *idea of choice between* these *alternative paths* of evolution; the *idea of tempo of evolution*, i.e., the speed of course of evolutionary processes in an open nonlinear system; the *idea of irreversibility of evolution*. The specific features of the phenomenon of nonlinearity are as follows. First, thanks to the nonlinearity, an important principle of 'the rank growth of a small', or 'the strengthening of fluctuations' is valid. Under certain conditions, the nonlinearity can strengthen fluctuations. It is able to transform an insignificant difference into an appreciable one which has macroscopic consequences. Second, special types of open nonlinear systems show another remarkable property – the existence of thresholds of sensitivity. Below a threshold, everything diminishes and disappears. Such events are to be forgotten, they don't leave any traces in nature, science or culture. On the contrary, everything increases excessively above a threshold. Co-evolutionary Complexity and Mastering of Time 257 Third, the nonlinearity gives rise to a certain quantum effect: the discreteness of evolutionary paths of nonlinear systems (media). It means that not any arbitrary (either conceivable or desirable) evolutionary path is possible in a given nonlinear system, but only a discrete spectrum of evolutionary paths is available and feasible for implementation in the system. By the way, the above-mentioned existence of thresholds of sensitivity of special types of open nonlinear systems is an indicator of their quantum nature as well. Fourth, the nonlinearity signifies the possibility of unexpected, so called emergent, changes of direction in the course of a certain process. It entails some consequences for the human activities connected with predictions of the future. Predictions as extrapolations from an available state of affairs are still, up to this day quite widespread in the studies of, at least, short-term perspectives. Because of nonlinearity of evolutionary processes in the world, such predictions are in principle unreliable and insufficient. The development occurs through accidental choices of a path around bifurcation points, and the change (such is the nature of things) is, as a rule, never repeated. The research results show that the picture of processes at initial or intermediate stages may be completely opposite to their picture at a developed, asymptotic stage. For example, the processes, which initially spread and faded, may kindle in time and become to be localized near a center of a structure. Such bifurcations are determined not by changes of parameters of a medium, but by the course of processes of self-organization of the medium. Of course, some forced or spontaneous changes of an open nonlinear medium itself can occur as well. If a medium becomes different, it entails quite naturally qualitative changes in the picture of its evolution. If we consider a deeper level, a transformation of a field of possible evolutionary paths of the medium takes place in such a case. And finally, the nonlinearity implies the notion of the possibility of superrapid development at certain evolutionary stages. The very fast evolving processes together with their peaking in open nonlinear media, so called blow-up regimes, have been studied by the Moscow synergetic school.

3. CO-EVOLUTION AS AN 'ART TO LIVE TOGETHER'

The idea of co-evolution was one of the most favorite ideas introduced in synergetics by the founder of the synergetic movement in Russia, my teacher Sergey P. Kurdyumov (1928–2004) and propagandized emphatically by him. I was lucky to collaborate closely with him during almost two decades. He talked about the synergetic discovery of *constructive principles of co-evolution of complex systems* and about the possibility to *master time and to construct a desirable future*. (A great scope of materials corresponding to these ideas may be found at his site: www.spkurdyumov.narod.ru). 258 Helena Knyazeva Why did Kurdyumov call the principles of co-evolution discovered by synergetics constructive ones? Because they may be used for the effective management activity, for the strategic vision of the future and for long-term planning, for elaboration of rational national and state policy in the modern globalizing world. Because the synergetic principles of co-evolution are substantial and oriented to the remote future, which is practically impossible to predict using the traditional methods. Because the deep understanding of the synergetic principles of co-evolution, of non-linear synthesis of parts into a sustainable evolutionary whole can and should underlie the modern 'art to live together', when promoting the strengthening of the position of tolerance and the preservation of diversity in globalizing communities (Knyazeva & Kurdyumov 2007). To train a holistic rather than analytical view is, to all appearances, the today's need of managerial practice. "To think globally in order to succeed in solving a local and peculiar problem!" – that is a slogan of the modern time. The

comprehension of the barest reform of systems of management is based on nontraditional knowledge of sociosynergetics, i.e., upon the understanding of laws of co-evolution and self-organization of complex social, economic and geopolitical systems. These results are of great and inestimable significance as a kind of worldview that is necessary for understanding the course of evolutionary processes in complex systems, to which kind of systems human and social systems *par excellence belong.* To carry out appropriate reforms of social management, it is necessary to change mentality, the very mode of thinking. Thinking should be global, nonlinear, holistic, solidary, based on the understanding of constructive principles of co-evolution, i.e., at bottom of fact, of rules 'to live together' and 'to develop together in a sustainable way'. In other words, to think globally means to think integrally and holistically, to understand ways of integration of structures, which develop in different tempos and are on different levels of development, into a united concordant evolutionary whole. Complexity of a structure is connected with its coherence. By coherence, we mean the concordance of tempos of life of structures by means of diffusive, dissipative processes that are a macroscopic manifestation of chaos. In order to build a complex organization, it is necessary to coherently joint subsystems within it, to synchronize tempos of their evolution. As a result of the unification, structures fall into one tempo-world, so they acquire one and the same moment of peaking; they start to co-exist in the same tempo-world (Knyazeva & Kurdyumov 2001). To create a complex structure, it is necessary to know how to unify structures 'of different ages', i.e., structures of different stages of evolution and having different rates (tempos) of evolution. It is necessary to know how to include the elements of 'memory', the biological memory, DNA, or the memory of culture, cultural traditions. Inasmuch as the structure-attractors, which characterize the developed, steady evolutionary stages of structures in the nonlinear world, are described by the invariant-group solutions, the spatial and temporal properties of structure-processes turn to be tightly bound. The dynamics of development of a complex structure needs a coordinated (with one and the same moment of peakCo- evolutionary Complexity and Mastering of Time 259 ing) development of substructures of 'different ages' within it; this leads generally to the breakdown of spatial symmetry. The insertion of 'memory' (of elements of the past) signifies the symmetry breakdown in space. Different but not arbitrary structures can be unified. The degree of connection of structures, which are to be integrated, and the stages of their development are not arbitrary as well. There are various but not arbitrary ways of unification of structures into integral ones. There is a restricted set of integration ways, ways of construction of a complex co-evolutionary whole. The selectivity (the quantum character) of ways of integration of parts into a whole is connected with the imposed requirement of existence in one and the same tempo-world, i.e., of development of all parts with one and the same moment of peaking. This is the physical basis of quantification by integration of complex evolutionary structures. If joinable structures have even slightly different from each other moments of peaking, then, near the moment of peaking (the singularity), they will become incomparable in intensity. Thus, the synthesis of relatively simple evolutionary structures in an entire complex structure occurs by the establishment of a common tempo of evolution in all unified parts (fragments, simple structures). The intensity of processes in various fragments of the complex structure (for example, for the social medium – a level of economic development, quality of life, provision with information, etc. in different countries) can be diverse. The fact of integration signifies that structures becoming parts of a whole acquire a common rate development. An integrated complex structure arises only if there is a certain degree of overlapping of simple structures. There must be a certain topology, 'architecture' of overlapping. A constructive 'sense of proportion' must be observed. If the area of overlapping is not sufficient, then the structures will develop independently, they will not feel each other, they will live in different tempo-worlds. However, if the overlapping is too wide, then the structures will flow together very fast, they will straight away 'degenerate' in one rapidly developing structure. One may attempt to formulate rules of symmetry breakdown, when uniting structures of 'different ages' into a whole and to indicate an optimum degree of connection (of overlapping of areas of localization) of substructures within a complex structure, a proper topology of their location, laws of switching of regimes and other factors, ensuring sustainable concordant development in one and the same tempo-world. When integrating structures, a magnitude of maxima of intensity of processes occurring in them must be in an appropriate way matched with their distance from a center. Three structures having equal maxima of intensity (levels of development), when integrating, settle themselves in apexes of an equilateral triangle. If one of these structures is more developed, the equilateral triangle turns into an isosceles one: bigger intensity of burning is 'compensated' by its bigger distance from a center of symmetry. But there is no continuity in such a mechanism of 'compensation', i.e., a majority of intermediate states is unstable and only selected, definite configurations of structures are metastable. The compensation of a magnitude of a maximum by its bigger distance from the center of symmetry of a 260 Helena Knyazeva complex structure 'works' in a

iscrete, quantized field of possibilities of integration. When maxima of intensity increase, a distance between them decreases (the model of 'converging waves of burning' is developed and studied by our scientific school), and, on the contrary, when they decrease, the distance increases. One can integrate structures with different powers of intensity by arranging them at different distances from the center and by observing certain forms of organization. The factor of unification of parts into a whole structure is chaos, dissipation, fluctuations or – for social structures – their analogue (exchange processes of various kinds). Chaos plays a constructive role not only in the moments of choosing a further evolutionary path, but also in the processes of assembling a complex evolutionary whole. Chaos leads to the establishment of coherence of development in all parts (substructures). To put it figuratively, chaos serves as a 'glue' that binds parts into a united whole. If a complex structure is organized from more simple ones in a right topological way (that is, if there are a certain degree of interaction and overlapping of substructures and a certain symmetry of 'architecture' of an emerging united structure), the united structure finds itself on a higher level of hierarchical organization, i.e., a step towards a super-organization is taken. Thereby, the rate of development of structures, which are integrated into a complex one, is being picked up. The rapidly developing structures 'pull to themselves' by their tempo of life the slowly developing structures. In case of right unification, a ratio of maxima of more developed structures to maxima of less developed ones remain constant, i.e., small, underdeveloped structures don't fall out into another tempoworld, they don't become a simple background for development of structures with bigger maxima, there is no decay of tempo-worlds. Besides, if an evolutionary whole is organized in a right topological way, the whole begins to develop at a rapid pace, which is higher than there was a pace of the most rapid developing structure before the unification. The path of unity and of integration of different parts into entire structures is not steady, permanent and monodirectoral. The evolutionary ascent towards more and more complex forms and structures passes through a number of cycles of decay and integration, of tearing off from the whole and inclusion in it, the slowdown of the processes and their acceleration. From the theory of self-organization, it follows that any open systems with strong nonlinearity are most likely to pulse. They have natural cycles of development: the stages of differentiation of parts alternate with the stages of their integration, scattering alternates with rapprochement, the weakening of bonds changes into their strengthening. The world seems to go towards a universal unity, a super organism. But it moves forward not monotonously but through certain fluctuations and pulsation. The stages of decay, even if partial, are followed by stages of more and more powerful unifications of structures. This modern scientific notion of complexity reminds us of the eastern images of 'rhythms of life' that are peculiar to our world, first of all, of the Chinese symbol Yin-Yang. Co-evolutionary Complexity and Mastering of Time 261 The cycles of increase and decrease of the intensity of processes, of decay and unifications of parts indicate regularity of nonlinear processes; the cycles are determined by the very nature of nonlinear processes. Any complex structures at the moment of maximum of accretion, or at the culmination of development (at the moment of peaking of processes), are subjected to the inner instability with respect to small perturbations, they are under the threat of decay. The history of humankind testifies that the world empires increased in size and became stronger to the maximum extent and in the end they came asunder, sometimes disappeared completely without leaving a trace. But if the beginning of decay of some geopolitical system is observed, it is reasonable, from the synergetic point of view, to pose a question: is the nonlinearity of the system sufficient to turn the evolutionary processes back, to switch them to another regime of the renewal of bonds, the attenuation of processes in the central domain and their stirring at the periphery of the structure? If the nonlinearity is not sufficient, then the former intensive processes may simply be extinguished and come to naught. Thus, the fundamental principle of behavior of complex nonlinear systems is the periodical alternation of stages of evolution and involution, the unrolling and the rolling, the explosion of activity, the increase of intensity of processes and their fading, weakening, the converging to the center, the integration and the disintegration, at least the partial decay. There are profound analogies here to the historical testimonies of the downfall of civilizations and the break-up of great world empires, to the cycles of Nikolai D. Kondratiev, the oscillatory regimes of John K. Galbraith, the ethnogenetic rhythms of Lev N. Gumilyov. At the initial stage of formation of a complex structure, its right topological organization is of great importance. When the process of integration occurs, the structures are not simply put together; they do not simply become parts of the whole in an unaltered, undistorted form. They become somehow transformed; they form strata on each other and intersect, and at the same time some of their parts fall out. As the physicists say in such a case, there exists an overlapping with the energy loss. This signifies that the unification leads to the economy of energy, to the diminution of material expenses and human efforts.

The topologically proper organization of structures in an entire evolutionary structure results in an approach to the moment of peaking, the moment of maximum development. The whole develops faster

than its integral parts. It is more profitable to develop together, since the joint, co-evolutionary development is connected with a saving of material (in particular, energetic), spiritual and other resources. Every new way of the topologically proper integration of structures, the appearance of successive layers (with bigger exponent of nonlinearity) of hierarchical organization picks up speed of development of the whole as well as its integral parts. Therefore, the evolutionary path to the building of more and more complex organizations of structures in the world is to a certain extent predetermined. We should lend our ears to Eliot's advice: "We must be still and still moving / Into another intensity / For a further union, a deeper communication" (Eliot 2000, 260). 262 Helena Knyazeva Co-evolution is *per se* 'the art to live together'. To follow the rules of coevolutions signifies to construct a preferable and sustainable future. An important task can be set: to define order parameters of evolution of states that determine a corridor of their sustainable co-evolution. General rules of co-evolution of complex social, economic and geopolitical structures on national, international and global scales, which arise from the methodological analysis of mathematical models, can be summarized in form of the following key notions:

a) it is *a common tempo* of development that is a key indicator of connection of complex structures into a single whole;

b) *non-uniqueness and involuntariness* of ways of assembling of a whole from parts;

c) structures-parts enter the whole not in an invariable form, they *are transformed and became deformed in a certain way in accordance with the peculiarities* of an emerging evolutionary whole;

d) for assemblage of a new complex structure, for re-crystallization of a medium, one needs to create a situation '*at the edge of chaos*' when small fluctuations are able to initiate a phase transition, to throw down the system in another state, and to set another course to the process of morphogenesis, another way of assembling of the complex whole. "The very nature of co-evolution is to attain the edge of chaos" (Kauffman 1995, 29). e) to make a dynamically evolving integral structure, a *proper topology* of combination of structures is of great importance;

f) in case of right, resonant unification of complex structures into the whole, a united super complex structure begins to develop at a higher rate ('it is profitable to live and to develop together'). Co-evolution is not simply a process of adjustment of parts to each other by formatting a complex whole, of their resonant positional relationship and of synchronization of tempos of development, but it is enactive cognition of the world by a human being, synergism of cognizing and constructing subject and of a medium surrounding him. This is also an interactive connection between human organizations and single individuals, the universal collaboration, complicity and solidarity, concerted efforts in construction and rebuilding of the world, and thereby of one's own mentality. This is disclosure of universal affinity of all with everything and of mysterious connection between the past, the present and the future.

4. THE TREE OF TIME. NON-LINEARITY OF THE FLOW OF TIME

To consider the modern scientific picture of the world, it is worth to recall an almost poetical image of time, which is given to us by Heraclites. The world was, is and will be an eternally living fire, which lights up according to a certain measure and goes out according to a certain measure, i.e., the world undergoes permanent changes, the switching of different regimes of evolution going on. The world does Co-evolutionary Complexity and Mastering of Time 263 not change in a linear and monotonous way. The change of the world is subordinated by certain cycles and rhythms, but it is a realm of random and emergent events as well. According to Heraclites, time is not a clock that is winded one and for all, it is neither a machine with a monotonously working mechanism nor a blacksmith automatically counting out blows, when letting down his hammer on an anvil, it is rather 'a child playing pebbles'. This image of a playing time and of a constant trial of possibilities of the world is very close to the spirit of synergetics. The world is open and overcrowded with possibilities and with structures-attractors until not realized, the world is a fount of possibilities. The implementation of a part of these possibilities, the test of what can be implemented and realized in the world *here and now* and what cannot, what is feasible and desired for implementation in the given situation which has a certain space-time configuration is exactly a *nonlinear image of time what can be elicited from the synergetic knowledge.* And one more preliminary note. At the beginning of the 20th century, natural sciences, by picking up the general spirit of Einstein's theory of relativity, consider a geometrization as an ideal, i.e., they try to represent time and force interactions through space and the changes of its properties. According to Einstein's views, time was spatialized, as it was a fourth dimension of space. And nowadays, at the beginning of the 21st century – due to the theory of self-organization of complex structures (synergetics) – time turns to be in the focus of attention. The emphasis is placed on

evolutionary and temporal, emergent and random characteristics of appearance of ordered structures in natural, human and social systems. It turns out to be possible now to represent space through time, because synergetics shows that the historical and evolutionary stages of development of a structure are represented and can be found out in the present spatial configuration of a complex structure-attractor. The spatial configuration can be treated as a unification of fragments of structures of 'different ages' that carry in themselves elements of 'memory of different depth'. The very space can be considered as a hierarchy of structures of 'different ages', of different temporal distinctness. Thus, the turn from a spatialization of time to a temporalization of space obviously occurs at present. What sense is put by synergetics in this new, nonlinear image of time? Paul Valéry says in his diaries that "time has its figures" (Valéry 1974, 1113). According to Ilya Prigogine, time becomes a "nascent property" (Prigogine 1997). This is not time of being, but time of becoming of organized, ordered structures in dissipative media (systems). This is time of morphogenesis of structures. This is also time of natural and, as a matter of fact, inevitable periods of catastrophes, a periodical falling out into chaos. A whole series of paradoxical notions that suggest the nonlinearity of the course of time in the processes of evolution and co-evolution of complex structures appears in the modern theory of self-organization. They are as follows:

a) pre-determination, the influence of the future, structures-attractors of evolution, when "the wind insensibly blows from the future" (F. Nietzsche). 264 Helena Knyazeva The synergetic idea of the influence of the future differs radically from the notions of attitude, anticipation, advanced reflection which is known in psychology and the study of behavior of animals (a frog sees a moving object and jumps to catch it, to eat up an insect). An attitude is a possibility desired for realization to a bigger or lesser degree, feasible a bigger or lesser degree. As opposed to it, a structure-attractor, in the case of falling of a system into a cone of attraction, cannot remain unrealized and incomplete, cannot be constructed only partially; this is already reality, the direct and immediate availability of the future, of a future form, exactly in such a shape as it will be in the future;

b) the past and the future are presented in the present, "the moment of 'now' retains all the preceding stages of development as well as all the subsequent ones", according to Edmund Husserl (1966, 111). Complex (by their configuration) spatial structure-attractors contain information of their past and the future; the past and the future are co-existed in them;

c) irreversibility and elements of reversibility of the course of time, the change of regimes which are opposite by implication but mutually complementary (the regime of rapid growth and localization and the regime of activity decay and of spread over old traces) as a way of maintenance of functioning of a complex organization; rhythms of the flow of time, "a rhythm lays a hazy coverlet on reality" (F. Nietzsche);

d) acceleration and slowing down of the course of evolutionary processes, the similarity of slow processes (on a quasi-stationary stage) and rapid ones (close to the moment of blow-up) in the case of automodel, i.e., self-similar, description by a power law; "time has its density", according to Gaston Bachelard) (1936, 107);

e) discreteness of time, quanta of the biological time (metabolic cycles of living creatures), of the cognitive time (frames of perception), of the historical time (lifetime of one generation amounting to about 40 years); "duration consists of moments devoid of duration" (Bachelard 1932, 25). Ilya Prigogine (1917–2003) over the time of his whole life aspired to implement his dream, which was expressed as far back as in 1937 in three short notes for a student journal. The dream consisted in the unification of natural sciences and philosophy through solving the riddle of time. He frankly spoke about the nonlinearity of time: "Chaque être complexe est constitué par une pluralité de temps 'branché les uns sur les autres', selon des articulations subtiles et multiples. L'histoire, que ce soit celle d'une être vivant ou d'une société, ne pourra plus jamais être réduite à la simplicité monotone d'un temps unique". ("Every complex being is constituted by a plurality of times branching one over another, according to their subtle and multiple articulations. The history, would it be the history of a living being or of a society, cannot any more be reduced to the monotonous simplicity of a unique time") (Spire 1999, 25).

Of course, this image of a bifurcating, branching time is metaphorical, but the inner spirit of our age of bifurcations is reverberated in it. As regards the philosophical notions of time, which are close to this vision of time initiated by synergetics, Co-evolutionary Complexity and Mastering of Time 265 in addition to Edmund Husserl, Friedrich Nietzsche and Gaston Bachelard, it is worth to mention the names of Nicolai Hartmann, Henri Bergson, Maurice Merleau- Ponty, Alfred Whitehead, and Martin Heidegger. The Argentine writer and thinker Jorge Luis Borges offered us a beautiful and deep image of non-linear time in his essay *The Garden of Divergent Paths* (1941). The image resembles the tree of times, whose branches do not only ramify and multiply, but also accrete and come together. Events,

which occur in different, never adjoining branches, exert no influence upon each other. As we could say from our synergetic point of view, these are parallel tempo-worlds that do not feel each other. The depth of this image consists in the possibility to play with the world, when penetrating in the thickness of its potencies, much better than we manage to do it in reality. The possible and unrevealed in the world are much richer than already revealed and realized in it. What is unrealizable, or at least hardly feasible in reality, can be scrolled in our imagination where we can build parallel worlds and test different possible lines of development of events in them. While, as a result of a complex act of existential choice, we usually reduce diversity of possibilities and realize only one path, the lyric hero in *The Garden of Divergent Paths* chooses all at once, goes all possible paths. Thereby he creates different future times that, in its turn, multiply and ramify. All outcomes materialize, and each of them gives rise to new crotches. In such a trial of the world, the unrevealed manifests itself, the unrealized exists simultaneously with the already realized and can interact with it; the virtual has the same strength as the real. The world turns to be cramped and saturated to the highest degree. All branches in the tree of evolution are highlighted. The synergetic view of time is close, on the one hand, to existentialism and phenomenology (I enter space and time from within it, it is no more external for me, the nature of my body determines the character of my perception of the world, cuts out the tissue of the world 'to my measure') and, on the other hand, to epistemological constructivism (I actively master time and build the future, I make my deliberate and weighted choice of a desirable future from a spectrum of different possible variants that are feasible in a given medium and in a given situation at the present moment).

5. CONSTRUCTING OF A DESIRABLE FUTURE

Effective management should be: a) soft and non-linear, b) strategic (i.e., oriented to attain remote ends and to actively construct the preferable future), c) should include social and economic risk management (diagnostics of social risks, estimation and justification of allowable risks, prognostication of consequences of venturesome decisions). The following notions are considered as core ones in the modern forecasting (futures studies): a) the image of the future, b) alternative possible futures, c) creating the future rather than predicting it. The vision of the world, which is fu266 Helena Knyazeva ture-oriented, is based on solidarity with the future. We should not wait for gifts from the future, we rather should create, construct a desirable and preferable future. This attitude towards creation of the future is an intermediate interpretation of constructivism in futures studies. In relatively simple mathematical and computational models, a result of fundamental importance has been obtained: a continuous nonlinear medium potentially contains in itself different kinds of localization processes (different kinds of structures). Medium is a united source that acts as a carrier of different forms of future organization and as a field of different evolutionary paths. In other words, there are discrete sets of evolutionary paths of complex systems into the future (Knyazeva 1999). The future states of complex systems escape our control and prediction. The future is open, not unequivocal. But at the same time, there is a definite spectrum of 'purposes' or 'aims' of development available in any given open nonlinear medium. If we choose an arbitrary path of evolution, we have to be aware that this particular path may not be feasible in a given medium. Only a definite set of evolutionary pathways are open, only certain kinds of structures can emerge. The synergetic principles of strategic management show how it is possible to multiply reduce the required time and the necessary efforts and to generate by means of a resonant influence the desirable and – what is no less important – feasible structures in a given complex system, i.e., certain structures from a discrete spectrum of potentially possible structure-attractors. Besides, they demonstrate how it is possible to achieve the proper and persistent unification of relatively simple evolutionary structures into more complex entities and to accelerate in that way the tempo of their evolution. The world we live in is non-linear and open. The world is creative. An unexpected and often charming new appears in it. The future is multiple and uncertain in our non-linear world; it is a fuzzy future. The non-linear world often gives surprises to us. In such a world, the probability of fulfilment of even improbable events increases. The science of synergetics is an optimistic attempt to cope with nonlinear situations and to make use of the methods of effective nonlinear management of complex systems in their states of instability. This is the way of attainment of a desirable and at the same time feasible future, the future that is coordinated with the own properties of complex systems. In order to succeed in constructive and management activity in the modern complex and globalized world and to build oneself properly in co-evolutionary processes, one should: a) know how to take robust decisions under the conditions of deep uncertainty which is determined by the increasing complexity of social processes. And for that an intellectual alliance (intellectual synergy) between prediction, production of innovations and entrepreneurial (management) activity is necessary;

b) know how to think globally and to act actively and interactively, in a way that is adequate to a situation (the principle of situatedness of action); Co-evolutionary Complexity and Mastering of Time 267 c) be in synergism with a medium, with an organization or enterprise which is under our management control (the principle of non-linear feedbacks which is being established between a subject and a medium of his/her activity); d) create a coherent and mutually concordant world fitting not only his/her own cognitive and constructive possibilities, but also inner latent tendencies of a medium (attitude towards not only desirable but also feasible future).

6. TO MANAGE COMPLEXITY MEANS TO MANAGE TIME

Complexity is the unity of plural and diverse elements. According to E. Morin, who argues the problem in the true philosophical context, complexity is "unitas multiplex", i.e., both "unity of diversity" and "unity in diversity" (Morin 1977, 147). According to the models of non-linear dynamics and evolution of open dissipative structures elaborated by the Moscow school, complexity of structures and of their behavior is conditioned, first of all, by their *tempos of evolution*. The tempo, or the rate of evolution of open nonlinear systems, is a key characteristic in exploring complexity. The thesis can be explained by a few ideas that are more concrete:

a) there are very fast, avalanche-like processes, the blow-up regimes, which are of great importance. An effect of localization, i.e., the structure formation, and the appearance of extremely complicated structures may be observed in these very regimes;

b) periodical alternation of various evolutionary regimes may take place. The change of tempo of evolution as well as of general character of the occurring processes is a basis for self-maintenance of complex structures in the world;

c) it is the tempo of evolution that serves as indicator of integration of structures developing with different speeds in a whole complex structure;

d) synchronization of tempos of evolution of different complex structures is a way of co-evolution and sustainable development in the world. To manage time, to put it more precisely: to master time, is to know how to unify complex structures in a resonant way, i.e., to create a common tempo-world which is able to accelerate development of a produced whole and its constituent parts. The path of co-evolution is a mutually beneficial path into the future. Co-evolution is 'the art to live in one tempo-world', when not curtailing diversity but maintaining and developing it on the levels of elements and separate subsystems. Then, in a self-organizing society, it is necessary to cultivate a feeling of responsibility of each state structure and of each individual for the whole in a plural and united world. 268 Helena Knyazeva

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